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ABSTRACT

As part of a project that identified the specific literacy skills required in ten occupations, this report provides two levels of instructional information about machine tool operators. Factual data are presented in Parts I and II for use in decision making by program developers, administrators, teachers, and counselors. These sections note the specific literacy requirements (reading, writing, listening, speaking, and mathematics) that were identified at three job sites and in three vocational training programs. Part III presents instructional methods/materials that adult basic education teachers can use to develop literacy skills while imparting job related knowledge. The lesson format is based on a directed reading activity and includes vocabulary and concept development, sentence and organizational structure, silent reading, and skill development. Appendixes list the technical vocabulary that machine tool operators need to know, the 100 words that represent 45% of the language sampled for the entire project, and occupational literacy requirements for the ten occupations that were studied. (AEA)

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THE LITERACY REQUIREMENTS OF A MACHINE TOOL OPERATOR ON THE JOB AND IN A VOCATIONAL TRAINING PROGRAM

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PROJECT ABSTRACT

THE IDENTIFICATION OF LITERACY REQUIREMENTS OF JOBS IN INDUSTRY AND CORRESPONDING VOCATIONAL TRAINING PROGRAMS

1.	Need Addressed:	Meeting the educational needs of adults with minimal literacy skills who wish to enter skilled or semi-skilled occupations.
2.	Population Served:	Adults with minimal literacy skills.
3.	Brief Description:	Specific literacy requirements (reading, writing, listening, speaking, and mathematics) of semi-skilled and skilled occupations in business, industry and vocational training programs were determined. The literacy demands of three work contexts and training programs for each of the ten occupations were analyzed and reported.
4.	Major Objectives:	To provide educators, counselors, and administrators with a description of the literacy requirements of semi-skilled and skilled occupations and training programs to which functionally illiterate adults aspire.
5.	Products:	A description of the literacy requirements necessary to hold a job in each of ten occupations and the corresponding requirements necessary to succeed in vocational training programs which prepare individuals for each of those occupations is provided. A booklet for each of the ten jobs was prepared.

INTRODUCTION

This project was undertaken in response to a need, expressed by adult basic educators and counselors, for information about the specific literacy skills necessary for success in several occupations. The occupations studied had been identified as desirable careers during informal interviews with adults who were enrolled in basic education programs in the Lafayette, Indiana area. Employment counselors and officials of the Office of Career Development confirmed that the occupations identified for study were appropriate. Because Greater Lafayette offers a wide range of occupational and training opportunities, the project staff was able to study both job sites and vocational training sites for each of the following occupations: account clerk, automotive mechanic, draftsman, electrician, heating and air conditioning mechanic, industrial maintenance mechanic, licensed practical nurse, machine tool operator, secretary, and welder.

Purpose and Audience

This report provides descriptive and instructional information to adult educators at two levels. Factual data are presented in Parts I and II for use in decision making by program developers, administrators, lead teachers, and counselors. Part III presents instructional methods and materials and is meant for use by adult basic education teachers. Members of both groups may be interested in the entire report, but in preparing it the project staff attempted to address the needs of the two audiences separately.

Procedures

To identify reading, writing, speaking, listening, mathematics, and other characteristics which are necessary for success both on the job and in the training program, three job sites and three vocational college courses were studied.

Required reading materials from each of the six settings were evaluated using two widely used readability formulas, the Dale-Chall Formula and the Fry Readability Graph. Readability estimates were computer assisted. A minimum 2000 word sample of written language was taken from each site. Special considerations and problems related to reading the technical materials were identified, and the relative use of reading as a work tool and as a learning tool was determined.

To identify speaking and listening requirements, one hour samples of oral language were recorded at each job site and in each vocational college course. Language recorded at each site was rated for its technical and formal qualities, and computer-analyzed to assess vocabulary and syntax. Written and oral language samples were used to develop the Key Technical Vocabulary List found in Appendix A. The combined language samples from all occupations studied were used to develop the Highest Frequency Word List found in Appendix B. A summary of the literacy requirements for all ten occupations studied is found in Appendix C.

Writing samples were obtained at each of the six sites and used to determine the nature of written communication demands on the job and in the vocational training program.

Mathematics demands were determined through surveys of materials from the job sites and classrooms. Instructors and supervisors

responded to a questionnaire about the specific mathematics skills necessary for job and/or training program success.

Important non-literacy characteristics were identified by supervisors who completed a rating scale which asked for their estimate of the importance to job success of such factors as cooperativeness, reliability, and attitude toward work.

The following sections of this report are organized according to the requirements of the job, the requirements of the training program, and instructional recommendations.

PART I

REQUIREMENTS ON THE JOB

Job Sites Studied

At each of three separate job sites the literacy demands placed on one machine tool operator were studied. Reading, writing, oral language and mathematics were the specific literacy skill areas examined. The roles of the workers studied were similar; each was responsible for the operation of machines which produced precision metal parts for automobiles and other machinery. From each job site, representative samples of the reading, writing, and mathematics tasks done on the job were obtained. Samples of oral language requirements were obtained by recording a randomly selected one-hour period of on-the-job verbal interaction. At each job site, the worker's immediate supervisor completed a questionnaire which was concerned with the importance of eleven worker characteristics. Supervisors were also asked to identify the mathematics skills necessary for job success and to estimate the amount of time per week the workers spent using mathematics and reading skills.

Reading Requirements

Supervisors stated that reading was necessary only five to ten percent of the time, but that the difficulty level of the required materials was high. Reading materials from the job sites included

procedures sheets for each task, scheduling sheets, procedures manuals, machinist handbooks, and blueprints. The required reading materials involved sentence/paragraph format as well as tables, charts, and other graphic formats for the presentation of information.

The style of writing encountered in most of the materials studied was highly technical. Handwritten memos from supervisors were less technical than other materials, yet they contained highly specialized words and concepts. Example I illustrates the technical language encountered at two of the machine tool operator job sites studied.

EXAMPLE I

Machine Tool Operator Reading Materials

A. Machinist's Handbook

"The accompanying table shows the amount the pinion diameter must be increased to avoid undercut. In this table, the number of pinion teeth ranges from 10 to 31 for a pressure angle of 14½ degrees because undercutting does not begin until the number of teeth is less than 18 as indicated by the lower part of the table." (Oberg, 1946, p. 671)

B. Operations Procedures

"1. Clean shavings from table.

2. Release locating pilots and clamp.

3. Remove pieces, lay aside piece to machine.

4. Position clamp bar, align to stops, partly secure clamps." (Operation Methods Manual, Ross Gear Division of TRW, Inc., 1976)

The difficulty of the required reading materials was estimated by computer analysis using the Dale-Chall Formula and the Fry Readability Graph. Because several materials were examined at each job site, and because of variation in the estimates made by the two methods, Table I below presents readability levels in ranges of difficulty. A range of tenth to twelfth grade level would indicate that the materials evaluated were similar in difficulty to materials used in high school.

TABLE I

Readability Estimates for On-The-Job Materials

Job Site One	Ninth grade to college level
Job Site Two	Eleventh grade to college graduate level
Job Site Three	Tenth grade to college graduate level

Readability formulas do not take into account factors such as reader motivation and interest or familiarity with difficult concepts and unusual vocabulary. It is likely, therefore, that the machine tool operators who read required on-the-job materials on a dialy basis without difficulty would have had difficulty reading high readability level materials from unfamiliar areas of specialization. In fact, military studies suggest that workers were able to successfully use familiar reading materials several levels higher than their measured reading abilities should have allowed (Sticht, 1975). The implications of this research for ABE instruction are discussed in Part III of this report.

Special Reading Considerations and Problems

The predominant style of writing encountered in on-the-job reading materials was technical, as illustrated in Example I. Machine tool operators who participated in the study reported that much of the reading that they did involved finding important information in tables or figures. Specifications manuals, scheduling sheets, and blueprints were the most frequently mentioned materials. Careful reading of specifications on blueprints and procedures sheets was critical because precision gauges must be set to exact specifications in order to prevent costly machining errors.

The ability to find and use information in tables was often required in the materials found at the job sites. Example II illustrates a typical table used by machine tool operators.

EXAMPLE II

Tabled Information

MATERIAL →
DESCRIPTION

WORK CENTER	SEQ #	OPERATION #	$ PER 100 PC	STD HOURS	
3035	01	H	33.20	8.33	HARDEN, WASH & DRAW
3014	02	0	3.15	.68	TUMBLAST
1613	03	1	1.52	.34	INSPECT FOR HARDNESS
221 [redacted]	04	[redacted]	[redacted]	33.81	25C [redacted] ** FACE FLANGE [redacted] CHUCK ON BODY
221 [redacted]	05	26 [redacted]	[redacted]	13.44	25C [redacted] ** TURN HUB [redacted] BORE & HUB CHUCK INT

Probably the most important aspect of reading on the job was the need for thoroughness and caution. For all tasks reported, the workers stated that failure to read material correctly would affect both them

and their work.

Uses of Reading on the Job

From the questionnaire discussed above, it was concluded that most of the reading done on the job by machine tool operators was done to obtain important information. The workers indicated that in most cases it was necessary to remember the information for periods ranging from a few minutes to a week. It was also stated that key information was reread rather than entrusted to memory. Estimates of time spent using reading on the job ranged from two hours to twelve hours per week. In every case, it was stated that incorrect reading of required materials would affect the worker and others.

Although reading was used primarily to accomplish work with little need for remembering the information obtained, the use of training handbooks and reference books required reading to be employed as a learning tool. Information obtained from such sources usually concerned methods or techniques for using special tools and accomplishing particular types of machining processes. Such information was memorized and integrated into the job skills of the worker with only an occasional need for review. Both types of reading skills, reading to do and reading to learn (Sticht, et al, 1977), are discussed in Instructional Recommendations, Part III of this report.

Writing Requirements

The ability to communicate through writing was rated to be relatively unimportant by job site supervisors. It was not important for the machine tool operators to be able to write in complete sentences,

nor was highly legible handwriting required. It was, however, essential that important information was communicated clearly. The style of writing that occurred on the job sites was informal and resembled the style of writing used in telegrams; non-essential words were omitted. The concise, abbreviated style of writing found on the job is illustrated in Example III.

EXAMPLE III

On-The-Job Writing Style

A. OPERATION PERFORMED: "press in bushing & burnish"

B. PROCEDURES: "Sizes on print, have gauges set or checked for size. Read and fill out work card daily."

A wide range of legibility was observed in the handwriting samples collected at the job sites. If communication of key information was possible, the operator's handwriting was accepted.

Mathematics Requirements

According to supervisors, a wide range of mathematics skills were required of machine tool operators on the job. At one job site, however, not even basic computational processes of addition, subtraction, multiplication, and division of whole numbers were required, although computational abilities with whole numbers and fractions were desirable. Other supervisor ratings indicated that computational skills with whole and fractional numbers were required and that working knowledge of measurement and the decimal system was necessary. Also, ability to

solve word problems and knowledge of geometry and algebra were rated as desirable. Estimates of the amount of work time spent on mathematics tasks ranged from zero to six hours per week. An example of an application of mathematics knowledge by machine tool operators is presented in Example IV.

EXAMPLE IV

Mathematics Applications for Machine Tool Operators

A. From a work order:

"Cut 7/16 off one end of hardened dowel pins. Overall length should finish at 2 9/16."

B. From a manual:

"The micrometer reading, as shown in Fig. 1, is .6875". The figure which is exposed is 7; so that .700" is too large a reading of the caliper."

It is apparent from the examples that reading and mathematics skills are sometimes applied simultaneously in machine tool work.

Oral Language Requirements

Oral language recorded at the job sites combined informal styles of speech with job-related technical concepts and vocabulary. Conversation was at times not job-related, but as a rule it focused on aspects of job tasks that were being performed. Giving and following verbal directions were important abilities noted on the tape recordings. Much job-related conversation involved verbal instructions such as those shown in Example V.

EXAMPLE V

On-The-Job Verbal Interaction

Worker: "I think that hub's the proper size."

Co-worker: "It's not the proper size at all. You'll probably have to put those things up to the deep counter board when you're off, go ahead and sign in on this operation, and then we'll go ahead and pick up..."

Discussion of on-the-job problems, such as the above, was common at all sites studied.

Key Non-Literacy Requirements

Supervisory personnel rated several worker characteristics according to their importance to overall job success. The following characteristics were rated as very important by all of the supervisors: ability to work cooperatively with others, good record of attendance, positive attitude toward work, ability to communicate through speaking, ability to follow spoken and written directions, and ability to read blueprints. In addition to highly rating the above qualities, the supervisors added that pride in work and respect for authority were also very important.

An interesting result of the rating scale is that all of the qualities listed above were rated as more important than reading and mathematics abilities. Moreover, two supervisors rated the first six characteristics listed above to be more important than job knowledge in achieving job success. The implications of these findings for ABE instruction are discussed in Part III of this report.

PART II

REQUIREMENTS OF THE VOCATIONAL TRAINING PROGRAM

The Courses Studied

The reading, writing, oral language, and mathematics requirements of three courses in a vocational college machine tool technician training program were studied. The courses, Drafting, Electrical Fundamentals, and Human Relations, were determined by the school administration and instructional staff to be representative of the training program. In other words, the literacy demands of other machine tool courses were judged to be about the same as those presented here.

Each of the courses studied combined lectures, readings, and practical projects and experiences designed to simulate situations encountered in business and industry. Reading, writing, oral language, and mathematics skills were routinely used in all of the courses studied.

Reading Requirements

The amount of time spent using reading and other literacy skills is typically higher in training programs than on the job. This is due to the need to present large amounts of information during relatively short periods of time. In the vocational college training program much more time was required for reading, according to instructor estimates,

than was necessary on the job. The difficulty of the materials and the styles of writing found in materials from the two environments, however, were similar.

Important qualitative differences between on-the-job and training program reading demands were also noted. That is, on-the-job reading is used primarily to get work done. In the training program, reading is used most often as a learning tool. In neither setting, however, was reading used exclusively as a work tool or as a learning tool. The concepts of reading to do and reading to learn (Sticht, et al., 1977) are discussed in the Uses of Reading section, below, and in Part III of this report.

Instructor estimates of the amount of time per week spent on reading tasks ranged from one hour to several hours per week. Thus, it was expected that as many as thirty hours per week would be spent reading by machine tool students who were enrolled in all three of the courses.

The style of writing found in required course materials in the training program was, like that found in on-the-job materials, highly technical. The human relations material was less technical but still used an expository style in presenting information. Excerpts from training program reading materials are presented in Example VI.

EXAMPLE VI

Training Program Reading Materials

Textbook Explanation

"There are several standard tapers used in the manufacture of machine tools and machine tool equipment. The two most commonly used are the Brown and Sharpe and the Morse tapers. Most lathe and drill press builders have adopted the Morse taper and the majority of milling machine manufacturers use the Brown and Sharpe taper in their milling spindles." (Grinding Instruction Program, Fairfield Mfg.)

The levels of readability, or difficulty, of the materials required in the training program courses were similar to those of materials found at the job sites. If reading had been the only learning mode used in presenting new information to students, it would have been more effective to use reading materials written at a lower level than those used by experienced operators. However, the vocational college instructors planned lectures and laboratory experiences to coincide with reading assignments. Thus, the effect of textbook difficulty was offset, and students were enabled to acquire basic job-related information without having to struggle with unfamiliar concepts and difficult reading materials at the same time.

Table II below presents the levels of readability for materials used in the three courses studied. As in the case of the on-the-job materials reported in Part I, readability levels are reported as ranges.

TABLE II

Training Program Readability Estimates

Course One	Ninth grade to college level
Course Two	Twelfth grade to college level
Course Three	Ninth grade to college level

It was noted in Part I of this report that readability formulas do not a count for factors such as motivation, interest, and reader familiarity with subject matter. The notion that motivation and knowledge of subject matter can reduce the perceived difficulty of reading materials is discussed in Part III, Instructional Recommendations.

Special Reading Considerations and Problems

Finding information in texts, tables, figures, and diagrams for immediate use was the predominant use of reading on the job. In the training program, however, reading was most often used as a learning tool.

The training program required a balance of careful reading and the ability to identify and remember important information. Textbooks contained tables and figures similar to those found in specifications and manuals found on the job, as well as sentence and paragraph texts. Important information was presented in all such formats. Laboratory tasks required skills in reading and following directions. Typical training program reading materials are illustrated in Example VI, above. Tables of key information observed in training program materials were similar to those illustrated in Examples II and IV.

Uses of Reading

As previously discussed, reading in the training program involved both reading to do and reading to learn. Reading to do required skill in finding and using information presented in formats ranging from sentences and paragraphs to tables and sketches. Following directions presented in written form was also important. Reading to learn required the ability to organize and remember information which was most often presented via sentence/paragraph expository writing which was paired with graphic illustrations.

Writing Requirements

The requirements for both grammaticality and legibility of writing were similar in the training program courses and on the job. The emphasis in both settings was concise communication of key information. Complete sentences were not required in written homework assignments or in laboratory work. Lack of legibility became a problem only when it interfered with communication of information.

Mathematics Requirements

Each of the instructors who participated in the study completed a questionnaire which asked for estimates of the importance of several mathematics skills to succeed in the machine tool courses that he or she taught. The instructors' estimates of the need for mathematics skills required ranged from no mathematics requirements in the human relations course to high level mathematics skills in the machine tool program. Instructor estimates of the amount of time spent per week on mathematics tasks, again, varied considerably. No time was

spent on mathematics in the human relations course, while up to six hours per week was spent on mathematics tasks in the remaining courses studied.

Oral Language Requirements

The style of language recorded during training program lectures was typically informal. The subject matter covered during the lectures, however, was highly technical. Comprehension of the lectures required some prior knowledge of the subject matter and attentive listening on the part of the students. The abilities to follow verbal directions and to take notes on important concepts were also necessary. Students were expected to relate diagrams on chalkboards and in textbooks to lecture content. Discussion and question and answer sessions were included in class periods. Example VII presents an excerpt from a typical classroom lecture period.

EXAMPLE VII

Classroom Language

INSTRUCTOR: "That was a good book."

STUDENT 1: "That was a pain in the butt."

STUDENT 2: "It was written by the man who teaches at MIT. I don't know, you'd think he'd get into it. Maybe he did, I guess."

INSTRUCTOR: "I used to work for guys at MIT."

STUDENT 1: "What?"

INSTRUCTOR: "Never mind, go back to work. Oh, this is where it's going to be difficult. Two pounds, uh, Steve, come up here. How would you do this?"

STUDENT 3: "Skip a plate. Five, eighteen, twenty."

INSTRUCTOR: "Right."

Informal discussion of work-related problems often occurred during class periods. Oral language was used in a similar fashion on the job.

PART III

INSTRUCTIONAL RECOMMENDATIONS

Project Overview

For machine tool operators, reading, writing, oral language, and mathematics skills required on the job and in the vocational training program were generally high.

The levels of reading skills required on the job were estimated to be in the range of upper high school level to college graduate level. In the vocational training program, the estimated readability of required materials extended from ninth grade level to college level. It was noted in previous sections of this report that knowledge of key technical concepts and vocabulary, combined with the familiarity gained through daily use of required reading materials, may reduce the perceived difficulty of reading tasks.

On the job and in the vocational training program, reading was used both as a tool for accomplishing work and as a tool for learning. Reading to do work was predominant on the job, where reading was used to find information and to check specifications for job tasks. Supervisors' estimates of the amount of time machine tool operators spent on job-related reading ranged from zero to six hours per week. In the vocational training program, reading was used more often as a learning

tool than it was on the job. Both on-the-job and training program reading tasks required careful, precise attention.

Writing on the job and in the training program required clear, concise communication of information. The styles of writing used often resembled that used in writing telegrams; words which did not effect meaning were omitted. Legibility was important only if it interfered with communication.

The levels of mathematics skills required by the jobs and training courses examined in the study were diverse. One supervisor and one instructor stated that mathematics skills were not required in their settings. However, mathematics skills through trigonometry were required at other sites. The amount of time spent on mathematics-related tasks on the job and in the training program ranged from a few minutes to six hours per week.

The oral language used on the job and in the training program required the ability to solve job-related problems and to make use of oral instructions and directions given by supervisors and instructors. Note taking skills and the ability to relate verbal information to graphic illustrations were necessary in the training program.

Job site supervisors, when asked to rate several worker characteristics in terms of their importance to job success, rated the following as very important: good attendance, positive attitude toward work, ability to work cooperatively with others, ability to communicate through speaking, and ability to follow both oral and written directions. All of these qualities were rated by the supervisors as more important than reading or mathematics abilities. Moreover, two supervisors rated the

qualities listed above to be more important than job knowledge.

A brief summary of how the literacy requirements of the machine tool operator compare to those of the other nine occupations studied is found in Appendix C.

Organization of ABE Lessons

The recommendations which follow are meant to aid teachers and tutors in designing streamlined lessons which develop literacy skills while imparting job-related knowledge. The majority of the literacy information studied in connection with the machine tool occupations and training program was related to reading. Reading demands were found to be high, and when mathematics, writing, and oral language skills were used by workers and students, they were usually used in conjunction with reading. This section, in presenting background information and a method of organizing ABE lessons, emphasizes reading. Provided background information deals with the teaching of vocabulary and teaching about text structure and organization. The lesson format is based on a directed reading activity (DRA) and includes vocabulary and concept development, sentence and organizational structure, silent reading, and skill development.

The guiding principle of a DRA method of lesson organization is that words, concepts, and skills must be introduced and practiced in situations and materials that are meaningful. For example, words, sentences, tables, and illustrations should be similar to those used on the job or in the training program. It may be possible to teach an interested ABE student all of the words on the Key Technical Vocabulary List in isolation, but a far better practice is to introduce and

practice such words in contexts similar to those found in occupational reading materials. In the case of ABE lessons, there may be a wide gap between the reading requirements of occupational materials and the reading abilities of the student. Materials which parallel those found on the job and in the training program can be developed by teachers and tutors if time permits. Through paraphrasing sections of textbooks, reference books, and manuals, the readability of occupational materials can be reduced so that literacy skills and job-related knowledge can be developed simultaneously.

The value of a DRA approach is that it allows the use of any appropriate reading material in a job-related reading skill development program.

Notes on Teaching Vocabulary

The specialized vocabularies of machine tool operators, working in different settings, are similar. There are many key concepts and words which are common to the machine tool occupation in general.

The specialized technical words of the Key Technical Vocabulary List should be taught to ABE students interested in entering the machine tool field so that both the words and their meanings are recognized. This implies that the words will be taught in a meaningful context.

Two types of specialized vocabulary words occur in technical fields such as machine tooling. One type of word is unique to the specific field. The word "collet" has a very specific meaning to machine tool operators and others working in their field, but persons outside of that field probably have never encountered the word. In teaching words such as "collet" to ABE students, an illustration of its meaning would be essential.

A second type of word which needs attention in ABE lessons is one which has a common meaning in everyday usage, but which also has a specialized technical meaning. The word "turn" has a meaning that is understood by all mature English speakers. In the machine tool field, however, "turn" refers to a specific machining process. Multiple meanings such as these should be pointed out during reading lessons.

It is important for ABE students to be introduced to common high-frequency words and specialized vocabulary words via contexts which are similar to those found on the job and in the training program. As noted previously, this practice develops basic job-related knowledge and reading ability.

The following are suggestions for teaching vocabulary:

1. Pair the word to be taught with the concept or object that it refers to whenever possible.
2. Introduce the word using an approach which focuses student attention on the word.
3. Be sure that the new word is read in context very soon after it has been taught.
4. Use the general rule that four to six new words per lesson be introduced. Learning and recall are typically most efficient when the number of words taught is in this range.
5. Review vocabulary words frequently.

Sources of job-related vocabulary words and concepts are included in the books cited in the bibliography of this report. The style and level of writing in the listed materials is often highly technical, thus, teacher time for preparing lower readability materials which parallel

high-level passages may be valuable.

Notes on Teaching About the Structure and Organization of Text

The above suggestions on teaching vocabulary emphasize meaning; words have little use outside of a meaningful context. In the machine tool field even solitary words on a chart or diagram have a meaningful context to a trained individual.

In reading, it is important to be aware of special patterns of organization used by writers. Formal technical reading materials are organized differently from the short stories and novels used in teaching reading to most Americans. The expository style of writing, used in textbooks and other specialized or technical materials is different, at several levels of comparison, from the narrative style of stories and novels.

At the sentence level, ABE students should learn that expository style often relates cause and effect. Sometimes this relationship is clearly stated as in the sentence in Example VIII-A.

EXAMPLE VIII

Stated and Unstated Cause and Effect Relationship

A. Because of the fuel shortage, he rode his bicycle.

B. There was a fuel shortage. He rode his bicycle.

Often, however, the relationship is not stated, as in Example VIII-B. In such cases, readers who are not expecting cause and effect connections may miss them. Often, in the machine tool materials examined during this study, the concise writing style caused some key connecting words, such

as "because", to be omitted. Those using technical reading materials should be aware of the occasional omission of connecting words.

At the paragraph level, writers of expository material often use a format which states the main idea in the first sentence. The last sentence summarizes the paragraph and may connect it to a paragraph that follows. Comprehension and learning can be improved when readers are aware of this organizational technique.

At the chapter level, expository material may contain many valuable aids to efficient reading. Key words are used as headings which introduced important sections. Pictures, diagrams, tables, and figures are used to illustrate important ideas. Introductions and chapter summaries are also available as aids to readers who know how to use them.

ABE students should learn about style factors such as these and use them to enhance comprehension. Efficient readers use their knowledge of expository style to organize their reading. Awareness of the use of cause and effect makes them sensitive to such relationships. Knowledge of paragraph and chapter organization is used in combination with prior knowledge and experience to develop a "mindset" which is helpful in organizing and remembering important information. Reader-composed questions based on paragraph lead-sentences, headings, pictures, and other graphic aids help readers organize, comprehend and remember what is read.

A directed reading activity described in the next section is a system which enables the ABE student to become efficient in using organizational factors as aids to comprehension and memory.

Directed Reading Activity

This system of preparation for efficient reading may be used with individual students or with groups. In groups, it requires very little class time to prepare students for reading assignments. For both individual and group use, it has been demonstrated to increase reading efficiency and comprehension.

After a review of previously taught, related concepts and assignments, the below procedures should be followed:

I. Develop Readiness for Reading the Assignment

Purpose: Motivate
Set purposes for reading
Develop vocabulary

Teacher role: Ask Questions -

How familiar is the subject matter and vocabulary to your student?

Teach New Vocabulary -

Be concrete: write out the words as you introduce them. Use examples, such as objects or pictures, to point out word relationships; i.e., cardiograph and cardiovascular relate to cardiac/heart. Have students write the words as they are taught.

Ask Questions to Stimulate Interest -

Focus on titles, pictures, graphs. Relate an anecdote from your own experience or one your students might have had.

II. Direct the Silent Reading of the Assignment

Develop questions from sub-headings, graphs, pictures, and tables. Try to focus on relationships in the assignment. In textbooks, useful questions are often provided by the authors.

Have pupils read silently for 5 to 20 minutes to find the answers (keeping questions in mind as they read).

Encourage students to ask for help when they are confused. Writing questions down in shorthand form is a good practice when reading is done outside of class.

III. Discuss Student Answers to Questions

Do not restate the questions unless necessary. Students need to remember the questions, or they lose the purpose for reading.

Ask higher level questions to develop comprehension. Have student(s) interpret, draw conclusions, and make inferences as well as recall facts.

IV. Reread as Necessary

When answers demonstrate confusion, have the student reread the appropriate small section to determine the reason for the confusion.

V. Follow-up and Skill Development

Confusion or lack of comprehension may signal a need for extra work on vocabulary, concept building, or word recognition skill.

In this phase of the lesson, important mathematics and other skills can be related concretely to the reading assignment.

REMEMBER:

A DRA is a system, a routine, that you want your student(s) to learn to use independently. Remind your students of this--tell them why you use a DRA system.

Reading to Accomplish Work

The term, reading to do, has been used in research and development projects done for the U.S. armed forces (Sticht, et al., 1977).

Reading to do refers to the use of reading for the purpose of getting work done. It involves following written directions and reading to find information which will be used immediately. Such information need not be learned or remembered. Looking up telephone numbers, finding information in a policy manual, or finding important data in a table, chart, or figure are examples of reading to do. Preparation of ABE studentes for reading-to-do tasks can be incorporated in a directed reading activity lesson.

When lesson materials contain occupationally relevant concepts, ABE students are given important background information which will make higher level training easier. Therefore, lessons should employ materials which are similar in structure and content to those found on the job or in the vocational training program. Paragraphs, tables, charts, and figures from on-the-job or instructional materials might be used verbatim. Alternatively, such materials might be paraphrased and reduced in difficulty to match student abilities.

Given appropriate materials and a period of orientation to them, the structural and organizational features of the table, chart, figure, paragraph, or chapter, should be pointed out to the student (see Notes on Teaching About Structure and Organization of Text). This is essentially the first step of the DRA described above. When the materials have been introduced, the student should be directed to find a particular fact in the material. In subsequent lessons, the difficulty of information-finding tasks should be increased.

Skill in following written directions can be developed using a DRA system in conjunction with job-related materials similar to Example IX. Initial activities should contain only one or two steps.

EXAMPLE IX

Written Directions

From a blueprint:

"1) 17/32 drill thru

2) 25/32 + 0 = 1/64 c'bore as shown

3) 17/32 ream to remove burr

4) 6 holes spaced as shown & in relation to 4 41/64 dia. holes as shown

5) 6.628-6.622 dia. B.C."

In information-finding lessons, the emphasis should be on understanding and careful identification of the required fact. Similarly, in lessons concerned with following directions, understanding and careful execution of the required steps must be emphasized.

Reading to Learn Information

Skill in learning printed information for future use is very important in vocational training programs. The reading skills necessary for reading to learn (Sticht, et al., 1977) are taught and systematically practiced in directed reading activity lessons. That is, the use of previewing, attention to graphic and contextual information, and the organizational factors discussed in Notes on Teaching About the Structure and Organization of Text, above, should be practiced and learned during each DRA lesson. Questioning and rereading, also aspects of a DRA, reinforce important learning skills.

Sources of materials for use in reading-to-learn lessons, like those employed in reading-to-do lessons, should be occupationally oriented (see Bibliography). ABE students who receive reading instruction through job-related reading materials develop not only reading skills, but gain important job knowledge as well.

Counseling the ABE Student

ABE students should be made aware of the importance of reliability, cooperation, ability to follow directi[illegible] and other factors noted in Part I of this report. On the basis of the responses of supervisors surveyed in this study and previous research (Sticht, 1975), it seems that such characteristics contribute as much or more to job success than do reading and mathematics skills. Role-playing activities which involve consideration for others and following directions may be a valuable part of ABE lessons designed to prepare adults for employment.

The literacy demands of the machine tool operator jobs and training program courses were high. It is, therefore, important that teachers, tutors, and counselors consider the facts presented earlier in this report, the individual students' levels of motivation, and literacy skill development before beginning to prepare the student to enter a machine tool operating job or vocational training program. Frequency and intensity of lessons, choice of instructional materials, and long-term duration of the instructional program will vary according to the students' literacy skill levels, especially in reading.

This does not mean that students with low literacy skills should always be discouraged from preparing for a machine tool operating career.

It does suggest, however, that an early and realistic estimate be made of the time and effort required to reach the goal of employment or formal training.

Summary

The literacy demands of machine tool operator jobs and training program courses were found to be generally high. It is probable, however, that individual experience and familiarity with specialized information reduces the perceived demands of job and training program tasks. The extent of such a reduction, however, is not known.

It was observed that the vocational training program for machine tool operators provided students with experiences that were similar to on-the-job tasks. Reading materials from the training program were less difficult than materials found at the job sites.

Instructional recommendations emphasized the development of reading skills. Other literacy and non-literacy requirements were recognized as important, but it was clear, even in cases where high level mathematics skills were necessary, that good reading skills were essential.

The recommended approach to ABE reading instruction was a directed reading activity (DRA) because it is systematic, provides for essential skill development and practice, and permits the use of any appropriate reading material. Suggestions were presented for teaching vocabulary and on the use of important structural and organizational factors which are related to reading comprehension and memory.

Two uses of reading, reading to do and reading to learn, were discussed separately because the skills they require are distinct.

Reading to do requires the ability to find information for immediate use; long-term memory is not necessary. Reading to learn requires awareness of organizational factors which aid in learning and remembering.

Non-literacy factors were discussed in the section, Counseling the ABE Student, because on-the-job supervisors rated several factors such as attendance and cooperativeness to be more important to job success than reading and mathematics ability, even though the demands for literacy were high for machine tool operators on the job.

Finally, it was recommended that, in using the information and recommendations presented here, ABE teachers should be well acquainted with the occupational interests, motivation, and literacy skills of their students. Some ABE students whose literacy skills are low may be unable to develop the skills necessary for job or school success within a period of time that seems reasonable to them. These students may choose to change their occupational objectives.

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APPENDIX A

TECHNICAL VOCABULARY LIST

This list is based on the total oral and written samples of the language of machine tool operators both on the job and in the training program. Words included in the most frequent 1000 words of the Kucera-Francis list (based on adult language) have been deleted. The list was also edited to remove numerals; labels; names of people, places, products, and companies; contractions and possessives; and colloquialisms resulting from the oral language samples.

Some words included in the list are relatively uncommon words that occurred in the total language sample and are not necessarily technical terms. Thus, the list should be treated as a source rather than a criterion. The 83 most common words have been marked with an asterisk.

Total Sample Words = 15,200

Different Words = 2,473

abilities	adults	analyze	aside	bar
ability	advantage	ancient	assembled	bare
abnormal	advantages	angle	assert	barrel
ac*	advent	angled	assistance	bars
accident	adverse	angles	assistant	base*
accidents	advice	angular	associated	bases
accomplish	affect	animal	assumed	basketball
accordance	affection	animals	attach	bathroom
accuracy	affects	anticipate	attachment	battery
accurate	afraid	anvil	attaining	battle
accurately	afternoons	anybody	attempt	bearing
achieve	afterward	apart	attitudes	bearings
achievement	ages	apathetic	attracted	beat
acidic	airplanes	appearance	attributed	becomes
activated	album	appendices	auction	beg
acts	albums	appliances	automated	begins
actual	align	application	automatically	behavior*
adaptable	alignment	applies	automobile	being
add	allowances	apply	avenue	bellhousing
address	allowed	appropriate	avoid	belonging
adjust	allows	approximate	avoided	bet
adjustable	alternator	arc	aware	bigger
adjusted	altitude	arise	backout	biggest
adjustment	aluminum	arm	balance	biological
admired	ammeter	armored	balanced	birds
adopted	ampere	arranged	ballast	birth
adult	amperes	arrangement	band	bisect

bisecting	breaker	careful	checking	collar
bisectors	breaking	carefully	cheek	collision
bit	brings	carries	chimney	columns
blade	broad	cassette	choosing	combination
blame	broke	cast	circle	comfort
blanks	broken	catatonic	circles	comfortable
blew	bucks	cathode	circuit*	commercial
block	builders	cathodes	circuits	commonly
blow	built	caused	circulate	compared
bobbin	bulb	causes	circumference	compass
bolt	burned	causing	citizen	compensate
books	bushings	ceiling	claim	completed
bore	buy	celebrating	clamp*	completing
bored	buyer	centers	classification	complex
boring	buzzes	centrifugal	clean	compliment
boss	buzzing	chair	cleaning	composition
bottle	cable*	chances	clearance	compound
bottom	calibrated	changed	cleats	compounded
bought	caliber*	changing	closely	compressor
bout	calling	charter	closer	computer
box	calls	characteristic	clothed	concentrate
boxes	cam	charged	clock	concept
brain	capacitance	charges	code	condition
brains	capacities	chased	coffee	conditioned
branch	capacitor*	cheap	coil*	conditioning
branches	capacity	check*	coils	conduct
break	card	checked	coincides	conductor

cone	controlled	crunch	denominator	dimension
conflict	controls	cured	depend	dimensions
confused	convenience	curve	dependency	directions
connect	convenient	curved	dependent	dirty
connected*	conversion	custom	depending	disagreement
connecting	cooking	cute	depends	disassociate
connection	cool	cutting	depth*	discharges
connector	cope	cycle	derived	disconnect
connectors	copper	cycles	describe	discovered
connects	cord	cylinder	designer	discussed
consecutive	cords	cylinders	desired	discusses
considerate	core	damage	detect	discussing
considering	corners	damp	determine	disease
considers	corrected	danger	develop*	disintegrate
consist	correspond	dangerous	developing	dislike
consistent	corridor	dangers	develops	dislikes
consists	costly	date	device	disorder
constant	counter	dealing	devices	disputable
constructed	covers	deciding	diagonal	distances
constructing	creates	decimal	diagonally	distinct
contact	crisec	decimals	diameter*	distinguish
contained	crisis*	deck	diameters	distructed
container	crisscross	decrease	diamond	disturbed
containers	critical	defining	die	divide
contentment	crosses	definite	dielectric	divided
continuous	crowded	definitely	differ	divisible
contribute	cruelty	degrees*	differently	divisions

dollars	edge	enclosed	evident	extremely
doses	effectively	ended	exactly	faced
dotted	effectiveness	ends	examples	factor
double	eight*	energized	excel	failure
downstairs	eighteen	energy	excuse	falling
downward	eighths	engage	executive	familiar
draftsman	eighty	engages	exert	families
drain	elbow	engines	existing	farad
draw*	elbows	enhances	expanded	farmer
drawer	elect	enters	expense	fashioned
drawing*	electric	environment	expensive	fastened
drawings	electrical	equal*	experience*	fatal
drawn	electrician	equalized	experiencing	fault
dress	electricity	equals	experiment	favor
drill	electromagnet	equipped	expert	favorable
drilled	electronic	equivalent	explain	fears
drills	electrons	erase	explained	feed
driver	electrostatic	erect	exposed	fellow
drives	elevation*	essence	expression	fields
driving	eleven	essential	extend	fifteen
drop	ellipse	essentially	extends	fifty
dropped	embarrassment	establish	extension	fig.*
dry	emotional	etc.	extensive	fighting
duct	emotionally	evaluates	extensively	fights
dude	emphasis	evenly	exterior	figured
duty	employed	eventually	external	filed
dynamic	empty	everyone	extra	financial

finds
finer
finish
finished
fires
fit
fitted
fitting
fix
fixed
fixture*
fixtures
flat
flow
fluctuating
flux
focus
follows
foot
forced
formulas
forty
fours
fourth
four-way
fractional
fractions
frame
frames
freezers
frequency
frequently
frictional
frustrating
frustrated
fun
functional
functioning
fuse
fused
gable
gallon
games
gas
gases
gassed
gauge*
gauges*
gear
generated
generator*
generators
gets
glandular
goes
gradual
graduated
graduation
greatest
grind
grinder
grinders
grinding
groove
grounded
grounding
grow
grows
guard
guards
guess
guide
guidelines
guns
guy
habits
hammer
handle
handled
handling
handout
handy
happen
happens
happiness
hardened
hardship
harm
hazard
heads
healthy
hearing
heat
heated
heating
heel
height
hello
helper
helping
hide
highest
highly
holds
hole
holes*
homes
hooked
horizontal
horsepower
horseshoe
hostile
household
hugged
humans
humor
hunger
hypotenuse
ice
identified
identify
identity
illness
illnesses
illustrate
imbalance
immeasurable
immediately
improperly
improved
inability
inaccurate
incessantly
inch*
inches*

included	insulation	jaws	lately	limit
includes	insulator	jobs	lathe	limits
inconvenience	insurance	join	lathes	linear
increases	intellectual	joint	laying	lingering
increasing	intense	joke	leak	liquid
independent	intensity	judging	leakage	listen
index	interact	judicial	leaking	literal
indicates	interaction	junior	lean	lives
induce	interchange	keeper	learn	load
inductor	intermediate	keeping	learning	loaded
infancy	internal	kicks	leaves	loading
infantile	interrupted	kidding	leaving	loads
influenced	intersect	kinds	leg	locate
influences	intersected	kitchen	legal	located
inner	intersection	knob	legislative	locating
inquiry	interwoven	knobs	legislator	location
inserted	intolerable	knock	legs	locations
inspecting	invention	knocking	lengths	locator
inspection	involve	knows	lessen	locators
installation	involvement	knurled	lesser	lock
instance	involves	ladies	leverage	locked
instances	iron	laid	levers	locking
instant	irregular	lamp	lifetime	logical
instinct	irritability	lamps	lighted	looks
instinctive	jacket	lapped	lighting	loosely
instructor	jarred	largely	liked	lose
instrument	jarring	largest	likes	losing

loss	math	mile	motors	octagon
losses	mature	mill	mounted	offers
lowest	matures	milliampere	mouth	officials
lucky	maturing	milling	movies	offset
lured	maturity	mills	multiple	offsetting
lyrics	maximum	minded	mutters	oil
machine*	meaningful	mine	named	older
machines	measure*	mini	names	opening
machining	measured	minor	narrow	openings
machinist	measurement	minute	navy	operate
machinists	measuring*	mishandled	nearby	operations
magical	mechanical	mistrust	necessarily	operator
magnet	mechanism	misused	need	opposite
magnetic	medium	miter*	negative	orators
magnetism	memory	miters	neurotic	ordinary
magnetized	mental*	model	neutral	organic
magnets	mentally	modify	nine	original
maintain	mercury	moldings	ninety	ourself
maintained	mess	molecules	noise	ourselves
majority	message	momentary	numbered	outer
manager	metal*	momentum	numerators	outgrow
manufacture	meter*	Monday	numerous	outlet
mark	meters	monster	nut	outlets
marked	metric	motivated	obtain	outline
marriage	microampere	motivation	obtaining	output
materials	micrometer*	motives	occupation	overheat
maternal	microphone	motor*	occurs	overlapping

overseas
oxygen
pace
pacemaker
paddle
pages
pain
painful
pairs
panel
papers
parallel
paralysis
pardon
parent
parents
partly
pass
passes
patients
patterns*
perceivable
perceive*
perception
perceptual
performed
permanent
permit
permits
perpendicular
personality*
phase
phases
phone
physically
physiological
pick*
picked
pieces*
pilots
pink
pipe*
pipes
pivots
places
plain
plainly
planers
planes
plate
plates
playing
pleasant
please
pleasure
plot
plug*
plugs
pole
poles
porcelain
portable
portion
pose
positive
potential
pound
pounds
practice
preceded
precision
predict
preferable
preferred
preheat
preheats
preliminary
prepare
prepared
preschool
presented
prevent
previous
primarily
principles
printed
probability
proceed
processes
produced
profile
profiles
profound
project
projecting
projection
proper
properly
protect
protection
protective
provides
psychological
psychoses
psychosis
psychosocial
psychotic
publicity
pull
pulled
pumps
purchased
purple
push
putting
quarter
quick
quickly
quieter
radius
rags
railroad
raised
rapid
rapidly
rare
rat
rated
react
readily
readings
reality
realize
ream
reasons

rebuilt
receive
recess
recesses
reckon
recognize
recognizes
recognizing
recorder
recording
rectangular
reduce
reduction
reevaluation
refer
refers
refrigerate
regardless
registered
regrind
regular
regulate
regulating
regulator
related
relation
relationship
relatively
relaxation
relaxed
release
relying
remarriage
remedied
remodeling
remove*
removed
repelling
repetition
replaced
represent
representation
represented
represents
require
requirement
requires
resetting
resistance
resolve
resolved
resolving
resources
respective
respects
respond
responds
responses
responsible
resulting
revenge
reverse
reversed
reversing
review
revolunteer
revolution
rid
ridiculous
ring
rings
rocks
rod*
rods
rolled
rotation
rough
round*
row
rpm
rub
rubber
rugged
rule
runs
safely
safety
salesman
sample
sang
satisfaction
satisfied
satisfies
satisfy
Saturday
scale*
schizophrenic
scientists
scoop
scoops
screen
screw*
screwed
screws
scribed
script
sealed
seam
secondary
sections
secure
security
seek
seeking
seethe
segments
seizing
seldom
self*
semicircle
semidiameter
semiprofile
senators
senses
sensory
separate
separating
separation
separators
seventy
severe
sewing
shape
shapes

sharp	sits	socket	splice	strung
shavings	sitting	sockets	spliced	stud
sheet*	sixteen	soft	splices	stuff
shelled	sixteenth	solid	split	substance
shield	sixteenths	solution	spoken	substitute
shipping	sixty	solutions	squared	success*
shock	sized	solve	stages	successful
shocked	sizes	solved	stamped	
shop	skid	solving	standards	supposed
shoulder	skilled	somebody	standing	surfaces
showing	skim	someone	starter	surge
shows*	skip	somewhere	starters	survival
shunt*	sleep	song	starting	suspended
shunts	slick	sounding	starts	sweat
shut	slides	source	steel*	swimming
sides	slight	spaces	stereo	switch*
sign	slightly	spare	stick	switches
signal	sling	spark	stimuli	symmetrical
signed	slip	speaking	stimulus	synchronous
significant	sloppy	specially	stops	synonymous
sill	slots	specifically	stored	tables
similarly	slotted	speed	storing	takes
simultaneous	smaller	speeds	strenghts	tale
sing	smallest	spend	strictly	talked
singing	smash	spin	striking	talking*
sink	smooth	spindle	strip	talks
sit	snap	spindles	struggling	tangent

tape	theirs	touching	twisted	versus
taper*	theories	trace	typical	vertical*
tapered	thereby	traced	uncle	viewed
tapering	thimble	transfer	unconscious	volt
tapers	thirst	transition	unfortunate	voltage*
taping	thirty	transmission	unique	volts
taps	threat	transmitted	unit	volumes
task	threats	treated	units	wagons
tasks	throttle	tremendous	unity	wait
taught	thrown	triangle	unknowns	walk
taut	thunder	triangles	unless	wants
taxpayers	thyself	trigger	unpleasant	warm
teaches	tickets	trip	unwillingly	warmth
telescopic	title	triton	upper	washing
telling	tolerance	truck	upset	waste
tempered	tolerances	trucking	urge	watt
tend	tolerate	trucks	uses	watts
tends	tolerating	trust	vacation	weakened
tension	tomorrow	tube	valve	wear
term	tonight	tubes	variation	wearing
terminal	tool*	tumor	varied	weights
terminals	toolroom	turning	varies	weld
terminated	tools*	turns	variety	welder
terrible	tore	turret	vary	wet
tested	torque	twentieth	varying	wheel
tester	totaled	twenty	vast	wheels
thank	touch	twice	vernier	whereas

whoever

width

wildwood

wind

winter

wipe

wire

wires

wiring

wise

withdrawal

wonder

workable

worker

workers

worn

wound

wrapper

wreck

wrecked

wrench

writer

yesterday

yourself

zero

zip

APPENDIX B

HIGHEST FREQUENCY WORD LIST

The 100 words on the following page represented 45% of the words used in all the language sampled. This list is based on the combined oral and written language samples from all occupations studied. It shows the words used most frequently by adults in the ten jobs studied and in the vocational training programs corresponding to those jobs.

Total Words	=	180,000
Total Different Words	=	9,000

the	will	your	see
of	one	was	more
to	not	get	these
and	an	has	into
a	there	must	just
is	can	any	them
in	when	he	down
it	out	got	time
for	we	know	about
that	which	then	been
you	what	don't	some
be	do	each	business
or	up	air	how
on	pressure	check	its
are	two	that's	back
I	so	but	over
this	they	system	work
with	here	through	would
as	other	valve	temperature
by	ok	going	same
if	right	well	also
have	no	use	where
all	used	than	now
at	may	it's	only
from	should	go	like

APPENDIX C

SUMMARY OF OCCUPATIONAL LITERACY REQUIREMENTS

This appendix presents a brief summary of the literacy requirements for all ten occupations studied.

SUMMARY OF OCCUPATIONAL LITERACY REQUIREMENTS

	On The Job		Training Program	
	Reading	Mathematics	Reading	Mathematics
Account Clerk	College to college graduate level	addition, subtraction, multiplication, division, decimals, fractions, business machines	11th grade to college graduate	addition, subtraction, multiplication, division, fractions, decimals. algebra
Automotive Mechanic	9th to college graduate level	basic processes, decimals, fractions, measurement	9th to college graduate level	basic processes, decimals, fractions, measurement
Draftsman	10th grade to college graduate	basic processes, through geometry, algebra, trigonometry	9th grade to college level	basic processes, through geometry, algebra, trigonometry
Electrician	college to college graduate level	basic processes, throguh geometry, algebra, trigonometry	10th grade to college graduate level	basic processes, through geometry, algebra, trigonometry
Heating and Air conditioning Mechanic	10th grade to college graduate level	basic processes, decimals, fractions, measurement, algebra	11th grade to college graduate level	basic processes, fractions, decimals, measurement
Industrial Maintenance Mechanic	10th grade to college graduate level	basic processes through trigonometry	10th grade to college graduate level	basic processes, decimals, fractions, measurement
Licensed Practical Nurse	10th grade to college level	addition, and subtraction--more necessary to dispense medication	12th grade to college graduate level	addition and subtraction
Machine Tool Operator	9th to college graduate	basic processes, decimals, measurement	9th grade to college level	basic processes, decimals, measurement
Secretary	College to college graduate level	basic processes, decimals, fractions, business machines	10th grade to college level	basic processes, decimals, business machines
Welder	few materials--reading of single word information required	basic processes, fractions, decimals, measurement	8th grade to college graduate level	basic processes, fractions, decimals, measurement, algebra